Kentucky's Commonwealth of Water
Teacher Fact Sheets

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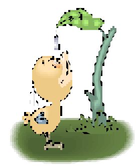
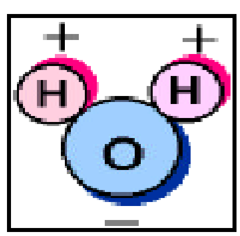


Looking at water, you might think that it's the most simple thing around. Pure water is colorless, odorless, and tasteless. But it's not at all simple and plain and it is vital for all life on Earth. Where there is water there is life, and where water is scarce, life has to struggle or just "throw in the towel." So what is it about water that makes it so important to us? And what is it about water that makes it water? This section explores the physical and chemical properties of water and why water is so critical to living things.

Water Properties

Water's Chemical Properties

You probably know water's chemical description is H_2O. As the diagram below shows, that is one atom of oxygen bound to two atoms of hydrogen. The hydrogen atoms are "attached" to one side of the oxygen atom, resulting in a water molecule having a positive charge on the side where the hydrogen atoms are and a negative charge on the other side, where the oxygen atom is. Since opposite electrical charges attract, water molecules tend to attract each other, making water kind of "sticky." (If the water molecule here looks familiar, remember that everyone's favorite mouse is mostly water, too).



Water’s physical properties

- Water is unique in that it is the only natural substance that is found in all three states -- liquid, solid (ice), and gas (steam) -- at the temperatures normally found on Earth. Earth's water is constantly interacting, changing, and in movement.
- Water freezes at 32° Fahrenheit (F) and boils at 212° F (at sea level, but 186.4° at 14,000 feet). In fact, water's freezing and boiling points are the baseline with which temperature is measured: 0° on the Celsius scale is water's freezing point, and 100° is water's boiling point. Water is unusual in that the solid form, ice, is less dense than the liquid form, which is why ice floats.
- Water has a high specific heat index. This means that water can absorb a lot of heat before it begins to get hot. This is why water is valuable to industries and in your car's radiator as a coolant. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.
- Water has a very high surface tension. In other words, water is sticky and elastic, and tends to clump together in drops rather than spread out in a thin film. Surface tension is responsible for capillary action, which allows water (and its dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies.
- Here's a quick rundown of some of water's properties:
  - Weight: 62.416 pounds per cubic foot at 32°F
  - Weight: 61.998 pounds per cubic foot at 100°F
  - Weight: 8.33 pounds/gallon, 0.036 pounds/cubic inch
  - Density: 1 gram per cubic centimeter (cc) at 39.2°F, 0.95865 gram per cc at 212°F

By the way:
1 gallon = 4 quarts = 8 pints = 128 ounces = 231 cubic inches
1 liter = 0.2642 gallons = 1.0568 quart = 61.02 cubic inches
1 million gallons = 3.069 acre-feet = 133,685.64 cubic feet

Common water measurements

The U.S. Geological Survey has been measuring water for decades. Millions of measurements and analyses have been made. Some measurements are taken almost every time water is sampled and investigated, no matter where in the U.S. the water is being studied. Even these simple measurements can sometimes reveal something important about the water and the environment around it.

Taking a single measurement of a water's properties is actually less important than looking at how the properties vary over time. For example, if you take the pH of the creek behind your school and find that it is 5.5, you might say "Wow, this water is acidic!" But, a pH of 5.5 might be "normal" for that creek. It is similar to how my normal body temperature (when I'm not sick) is about 97.5 degrees, but my third-grader's normal temperature is "really normal" -- right on the 98.6 mark. As with our temperatures, if the pH of your creek begins to change, then you might suspect that something is going on somewhere that is affecting the water, and possibly, the water quality. So, often, the ***changes*** in water measurements are more important than the actual measured values. pH is only one measurement of a water body's health; there are others, too.

Water temperature

Water temperature is not only important to swimmers and fisherman, but also to industries and even fish and algae. A lot of water is used for cooling purposes in power plants that generate electricity. They need cool water to start with, and they generally release warmer water back to the environment. The temperature of the released water can affect downstream habitats. Temperature also can affect the ability of water to hold oxygen as well as the ability of organisms to resist certain pollutants.

pH

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidity/basicness of the water. Water with a pH of 5 is ten times more acidic than water having a pH of six.
Pollution can change a water's pH, which in turn can harm animals and plants living in the water. For instance, water coming out of an abandoned coal mine can have a pH of 2, which is very acidic and would definitely affect any fish crazy enough to try to live in it! By using the logarithm scale, this mine-drainage water would be 100,000 times more acidic than neutral water -- so stay out of abandoned mines.

Specific conductance

Specific conductance is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water. Pure water, such as distilled water, will have a very low specific conductance, and sea water will have a high specific conductance. Rainwater often dissolves airborne gasses and airborne dust while it is in the air, and thus often has a higher specific conductance than distilled water. Specific conductance is an important water-quality measurement because it gives a good idea of the amount of dissolved material in the water. Probably in school you've done the experiment where you hook up a battery to a light bulb and run two wires from the battery into a beaker of water. When the wires are put into a beaker of distilled water, the light will not light. But, the bulb does light up when the beaker contains salt water (saline). In the saline water, the salt has dissolved, releasing free electrons, and the water will conduct an electrical current.

Turbidity

Turbidity is a measure of the cloudiness of water. It is measured by passing a beam of light through the water and seeing how much is reflected off particles in the water. Water cloudiness is caused by material, such as dirt and residue from leaves, that is suspended (floating) in the water. Crystal-clear water, such as Lake Tahoe (where they work hard to keep sediment from washing into the lake) has a very low turbidity. But look at a river after a storm -- it is probably brown. You're seeing all of the suspended soil in the water. Lucky for us, the materials that cause turbidity in our drinking water either settle out or are filtered before the water arrives in our drinking glass at home. Turbidity is measured in nephelometric turbidity units (NTU).

Dissolved oxygen

Although water molecules contain an oxygen atom, this oxygen is not what is needed by aquatic organisms living in our natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. This dissolved oxygen is breathed by fish and zooplankton and is needed by them to survive.
Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, while stagnant water contains little. The process where bacteria in water helps organic matter, such as that which comes from a sewage-treatment plant, decay consumes oxygen. Thus, excess organic material in our lakes and rivers can cause an oxygen-deficient situation to occur. Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material in it, especially in summer, when dissolved-oxygen levels are at a seasonal low.

Hardness

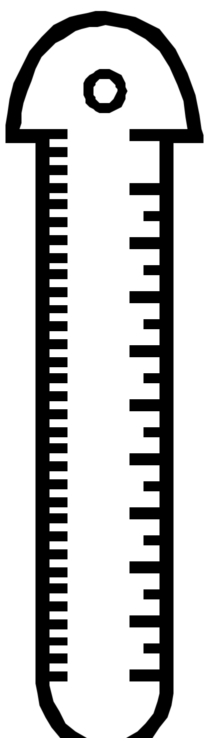
The amount of dissolved calcium and magnesium in water determines its "hardness." Water hardness varies throughout the United States. If you live in an area where the water is "soft," then you may never have even heard of water hardness. But, if you live in Florida, New Mexico, Arizona, Utah, Wyoming, Nebraska, South Dakota, Iowa, Wisconsin, or Indiana, where the water is relatively hard, you may notice that it is difficult to get a lather up when washing your hands or clothes. And, industries in your area might have to spend money to soften their water, as hard water can damage equipment. Hard water can even shorten the life of fabrics and clothes! Does this mean that students who live in areas with hard water keep up with the latest fashions since their clothes wear out faster?

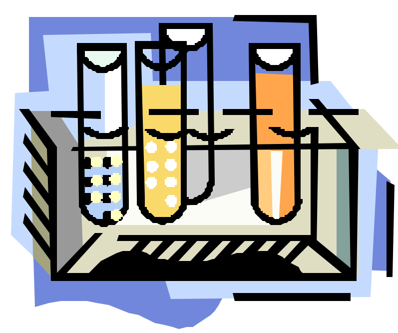
Suspended sediment

Suspended sediment is the amount of soil moving along in a stream. It is highly dependent on the speed of the water flow, as fast-flowing water can pick up and suspend more soil than calm water. During storms, soil is washed from the stream banks into the stream.

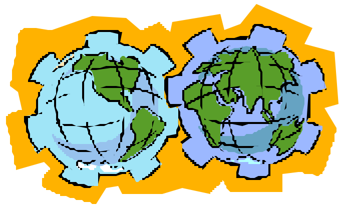
The amount that washes into a stream depends on the type of land in the river's drainage basin and the vegetation surrounding the river. If land is disturbed along a stream and protection measures are not taken, then excess sediment can harm the water quality of a stream. You've probably seen those short, plastic fences that builders put up on the edges of the property they are developing. These silt fences are supposed to trap sediment during a rainstorm and keep it from washing into a stream, as excess sediment can harm the creeks, rivers, lakes, and reservoirs.

Sediment coming into a reservoir is always a concern; once it enters it cannot get out - most of it will settle to the bottom. Reservoirs can "silt in" if too much sediment enters them. The volume of the reservoir is reduced, resulting in less area for boating, fishing, and recreation, as well as reducing the power-generation capability of the power plant in the dam.





Water on Earth



Where is Earth's water?

The Earth is doing a balancing act with its water*!* Water is continually moving around, through, and above the Earth as water vapor, liquid water, and ice. In fact, water is continually changing its form. The Earth is pretty much a "closed system," like a terrarium. That means that the Earth, as a whole, neither gains nor loses much matter, including water. Although some matter, such as meteors from outer space, are captured by Earth, very little of Earth's substances escape into outer space. This is certainly true about water. This means that the same water that existed on Earth millions of years ago is still here. Thanks to the water cycle the same water is continually being recycled all around the globe. It is entirely possible that the water you drank for lunch was once used by a Mama Brontosaurus to give her baby a bath.

As you know, the Earth is a watery place. About 70 percent of the Earth's surface is water-covered. But water also exists in the air as water vapor and in the ground as soil moisture and in aquifers. Thanks to the water cycle our planet's water supply is constantly moving from one place to another and from one form to another. Things would get pretty stale without the water cycle!

When you take a look at the water around you, you see water in streams, rivers, and lakes. You see water sitting on the surface of the earth. Naturally, this water is known as "surface water." Your view of the water cycle might be that when rain falls it fills up the rivers and lakes. But, how would you account for the flow in rivers after weeks without rain? In fact, how would you account for the water flowing down your driveway on a day when it didn't rain? The answer is that there is more to our water supply than just surface water, there is also plenty of water beneath our feet.

Even though you may only notice water on the Earth's surface, there is much more water stored in the ground than there is on the surface. In fact, some of the water you see flowing in rivers comes from seepage of ground water into river beds. Water from precipitation continually seeps into the ground to recharge the aquifers, while at the same time water from underground aquifers continually recharges rivers through seepage.

Humans are happy this happens because people make use of both kinds of water. In the United States in 1995, we used about 321 billion gallons per day of surface water and about 77 billion gallons per day of ground water. In a way, that underestimates the importance of ground water, since not only does ground water help keep our rivers and lakes full, it also provides water for people in places where visible water is scarce, such as in the desert towns of the Western United States. Without ground water, people would be sand-surfing in Palm Springs, CA. instead of playing golf!

Just how much water is there on (and in) Earth? Here are some numbers.

- The total water supply of the world is 326 million cubic miles (a cubic mile is an imaginary cube (a square box) measuring one mile on each side). A cubic mile of water equals more than one trillion gallons.
- About 3,100 cubic miles of water, mostly in the form of water vapor, is in the atmosphere at any one time. If it all fell as precipitation at once, the Earth would be covered with only about 1 inch of water.
- The 48 contiguous United States receive a total volume of about 4 cubic miles of precipitation each day.
- Each day, 280 cubic miles of water evaporate or transpire into the atmosphere.
- If all of the world's water was poured on the United States, it would cover the land to a depth of 90 miles.
- Of the freshwater on Earth, much more is stored in the ground than is available in lakes and rivers. More than 2,000,000 cubic miles of fresh water is stored in the Earth, most within one-half mile of the surface. Contrast that with the 60,000 cubic miles of water stored as fresh water in lakes, inland seas, and rivers. But, if you really want to find fresh water, the most is stored in the 7,000,000 cubic miles of water found in glaciers and icecaps, mainly in the polar regions and in Greenland.

Follow a drip through the water cycle

You may be familiar with how water is always cycling around, through, and above the Earth, continually changing from liquid water to water vapor to ice. One way to envision the water cycle is to follow a drip of water around as it moves on its way. I could really begin this story anywhere along the cycle, but I think the ocean is the best place to start, since that is where most of Earth's water is.

If the drip wanted to stay in the ocean then it shouldn't have been sunbathing on the surface of the sea. The heat from the sun found the drip, warmed it, and evaporated it into water vapor. It rose (as tiny "dripettes") into the air and continued rising until strong winds aloft grabbed it and took it hundreds of miles until it was over land. There, warm updrafts coming from the heated land surface took the dripettes (now water vapor) up even higher, where the air is quite cold. When the vapor got cold it changed back into it a liquid (the process is condensation). If it was cold enough, it would have turned into tiny ice crystals, such as those that make up cirrus clouds. The vapor condenses on tiny particles of dust, smoke, and salt crystals to become part of a cloud.

precipitation. Earth's gravity helped to pull it down to the surface. (Maybe it would land on a leaf in a tree, in which case it would probably evaporate and begin its process of heading for the clouds again. If it misses a leaf there are still plenty of places to go.)

The drop could land on a patch of dry dirt in a flat field. In this case it might sink into the ground to begin its journey down into an underground aquifer as ground water. The drop will continue moving (mainly downhill) as ground water, but the journey might end up taking tens of thousands of years until it finds its way back out of the ground . Then again, the drop could be pumped out of the ground via a water well and be sprayed on crops (where it will either evaporate, flow along the ground into a stream, or go back down into the ground). Or the well water containing the drop could end up in a baby's drinking bottle or be sent to wash a car or a dog. From these places, it is back again either into the air, down sewers into rivers and eventually into the ocean, or back into the ground.

But our drop may be a land-lover. Plenty of precipitation ends up staying on the earth's surface to become a component of surface water. If the drop lands in an urban area it might hit your house's roof, go down the gutter and your driveway to the curb. If a dog or squirrel doesn't lap it up it will run down the curb into a storm sewer and end up in a small creek. It is likely the creek will flow into a larger river and the drop will begin its journey back towards the ocean.
If no one interferes, the trip will be fast (speaking in "drip time") back to the ocean, or at least to a lake where evaporation could again take over. But, with 250+ million people here needing water for most everything, there is a good chance that our drop will get picked up and used before it gets back to the sea.

A lot of surface water is used for irrigation. Even more is used by power-production facilities to cool their electrical equipment. From there it might go into the cooling tower to be evaporated. Talk about a quick trip back into the atmosphere as water vapor -- this is it. But maybe a town pumped the drop out of the river and into a water tank. From here the drop could go on to help wash your dishes, fight a fire, water the tomatoes, or (shudder) flush your toilet. Maybe the local steel mill will grab the drop, or it might end up at a fancy restaurant mopping the floor. The possibilities are endless -- but it doesn't matter to the drip, because eventually it will get back into the environment. From there it will again continue its cycle into and then out of the clouds, this time maybe to end up in the water glass of the President of the United States.

The Water in You

Think of what you need to survive, really just survive. Food? Water? Air? Naturally, we are going to concentrate on water here. Water is of major importance to all living things; in some organisms, up to 90 percent of their body weight comes from water. Up to 60 percent of the human body is water, the brain is composed of 70 percent water, blood is 82 percent water, and the lungs are nearly 90 percent water.

There just wouldn't be any you, me, or Fido the dog, without the existence of an ample water supply on Earth. The unique qualities and properties of water are what make it so important and basic to life. The cells in our bodies are full of water. The excellent ability of water to dissolve so many substances allows our cells to use valuable nutrients, minerals, and chemicals in biological processes. Water's "stickiness" (from surface tension) plays a part in our body's ability to transport these elements all through ourselves. The carbohydrates and proteins that our bodies use as food are metabolized and transported by water in the bloodstream. No less important is the ability of water to transport waste material out of our bodies.

Surface Water

About 80 percent of all the water we use in everyday life comes from surface-water sources such as rivers, streams, lakes, and reservoirs. The other 20 percent comes from ground-water. It is only natural that we heavily use our surface-water resources. After all, it is a lot easier and cheaper to get water out of a river than it is to drill a well and pump water out of the ground. Also, rivers are more accessible to us -- we generally build our towns and cities next to a river or lake.

For certain purposes, such as irrigation and supplying towns and cities with water, the United States relies heavily on surface water. Other users, such as mining and livestock industries rely more on ground water.

Rivers and streams

Rivers? Streams? Creeks? They are all names for water flowing on the Earth's surface. As far as this site is concerned, they are pretty much interchangeable. I tend to think of creeks as the smallest of the three, with streams being in the middle, and rivers being the largest.

A river is nothing more than surface water finding its way over land from a higher altitude to a lower altitude, all due to gravity. When rain falls on the land, it either seeps into the ground or becomes runoff, which flows downhill into rivers and lakes, on its journey toward the seas. In most landscapes the land is not perfectly flat -- it slopes downhill in some direction. Flowing water finds its way downhill initially as small creeks. As small creeks flow downhill they merge to form larger streams and rivers. Rivers eventually end up flowing into the oceans. If water flows to a place that is surrounded by higher land on all sides, a lake will form. If man has built a dam to hinder a river's flow, the lake that forms is a reservoir.

Runoff: Point and Nonpoint Source Pollution

When rain or snow falls onto the earth, it just doesn't sit there -- it starts moving according to the laws of gravity. A portion of the precipitation seeps into the ground to replenish Earth's ground water. Most of it flows downhill as runoff. Runoff is extremely important in that not only does it keep rivers and lakes full of water, but it also changes the landscape by the action of erosion. Flowing water has tremendous power -- it can move boulders and carve out canyons (check out the Grand Canyon. It was made by water!) Special terms are used to describe the types of runoff pollution that occurs. These terms are nonpoint source pollution and point source pollution. Nonpoint source pollution means that the pollution is coming from many sources at once. An example of this would be runoff from lawn chemicals throughout a neighborhood or town. Point source pollution comes from a particular place or point. An example of point source water pollution would be a large trash dump that was leaking chemicals into a stream. Sewer pipes that discharge directly into streams are considered nonpoint source pollution because they are so numerous and so difficult to find.

Rivers and sediment

Rivers and streams are hardly ever crystal clear. As the rivers move they are carrying soil, sand, and sediment along with them. The sediments that rivers transport actually play quite an important role in shaping the environment and even in our own lives.

When it rains, soil and debris from the surrounding land are eroded and washed into streams. From there, sediment particles from as small as clay to as large as boulders flow along with the water. Fast-moving water can pick up, suspend, and move larger particles more easily than slow-moving waters. This is why rivers are more muddy-looking during storms -- they are carrying a **LOT** more sediment than they carry during a low-flow period. In fact, so much sediment is carried during storms that well over one-half of all the sediment moved during a year might be transported during a single storm period.

The U.S. Geological Survey does quite a lot of work measuring how much sediment is transported by streams across the country. To do this, both the amount of water flowing past a site (streamflow or flow) and the amount of sediment in that water (sediment concentration) must be measured. Both streamflow and sediment concentration are continually changing. A river discharge measurement is performed to measure streamflow. As streamflow goes up and down during a storm, hydrologists take measurements of how much sediment is in the water at different streamflows. Once we know how much water is flowing and the amount of sediment in the water at different flow conditions, we can compute the tonnage of sediment that moves past the measurement site during a day, during the storm, and even during the whole year.

So what does this have to do with people? On the plus side, sediment deposited on the banks and flood plains of a river is often mineral-rich and makes excellent farmland. The Nile in Egypt and the Mississippi River here in the United States are good examples. On the negative side, when rivers flood, they leave behind many tons of wet, sticky, heavy, and smelly mud -- not something you would want in your basement. You may recall the disastrous effects of the Midwest flooding of 1995 and 1997. Sediments can also harm dams and reservoirs. When a river is dammed and a reservoir is created, the sediments that used to flow along with the relatively fast-moving river water are, instead, deposited in the reservoir. This happens because the river water flowing through the reservoir moves too slowly to keep sediment suspended -- the sediment settles to the bottom of the reservoir. Reservoirs slowly fill up with sediment and mud, eventually making them unusable for their intended purposes.

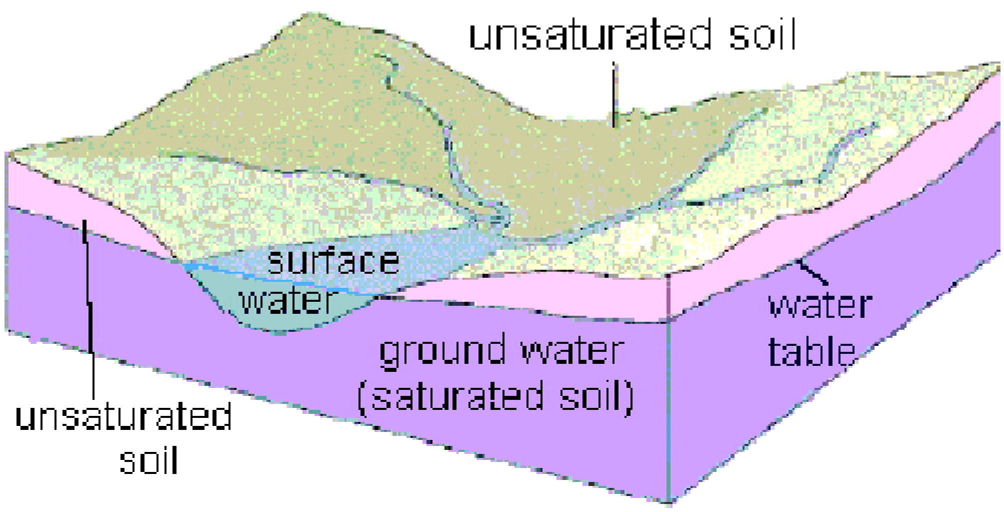
Even more important, sometimes the sediment that washed away is soil we need to grow crops. The government agency known as the Natural Resource Conservation Service was once known as the Soil Conservation Service. It was established specifically to help people understand how important it is to conserve soil. Once soil is washed away, it takes thousands of years for nature to replace it.

Ground water

What is ground water?

Ground water is the part of precipitation that seeps down through the soil until it reaches rock material that is saturated with water. Ground water slowly moves underground, generally at a downward angle (because of gravity), and may eventually seep into streams, lakes, and oceans.

Here is a simplified diagram showing how the ground is saturated below the water table. The ground above the water table may be wet to a certain degree, but it does not stay saturated. The dirt and rock in this unsaturated zone contain air and some water and support the vegetation on the Earth. The saturated zone below the water table has water that fills the tiny spaces (pores) between rock particles and the cracks (fractures) of the rocks.



Why is there ground water?

A couple of important factors are responsible for the existence of ground water:

(1) Gravity

Nothing surprising here - gravity pulls water toward the center of the Earth. That means that water on the surface will try to seep into the ground below it.

(2) The Rocks Below Our Feet

The rock below the Earth's surface is the bedrock. If all bedrock consisted of a dense material like solid granite, then even gravity would have a hard time pumping water downward. But Earth's bedrock consists of many types of rock, such as sandstone, granite, and limestone. Bedrocks have varying amounts of void spaces in them where ground water accumulates. Bedrock can also become broken and fractured, creating spaces that can fill with water. And some bedrock, such as limestone, is dissolved by water -- which results in large cavities that fill with water.

In many places, if you looked at a vertical cross-section of the earth you would see that rock is laid down in layers, especially in areas of sedimentary rocks. Some layers have rocks that are more porous than others, and here water moves more freely (in a horizontal manner) through the earth. Sometimes when building a road, the layers are revealed by road cuts, and water can be seen seeping out through the exposed layers.

Try as it might, gravity doesn't pull water all the way to the center of the Earth. Deep in the bedrock there are rock layers made of dense material, such as granite, or material that water has a hard time penetrating, such as clay. These layers may be underneath the porous rock layers and, thus, act as a confining layer to retard the vertical movement of water. Since it is more difficult for the water to go any deeper, it tends to pool in the porous layers and flow in a more horizontal direction across the aquifer toward an exposed surface-water body, like a river.

Visualize it this way: get two sponges and lay one on top of the other. Pour water (precipitation) on top and it will seep through the top sponge downward into the bottom sponge. If you stopped adding water, the top sponge would dry up and, as the water dripped out of the bottom sponge, it would dry up too. Now, put a piece of plastic wrap between the sponges, creating your "confining layer" (making the bottom sponge an impermeable rock layer that is too dense to allow water to flow through it). Now when you pour water on the top sponge, the water will seep downward until it hits the plastic wrap. The top sponge will become saturated, and when the water hits the plastic wrap it won't be able to seep into the second sponge. Instead, it will start flowing sideways and come out at the edges of the sponge (horizontal flow of ground water). This happens in the earth all the time -- and it is an important part of the water cycle.

Groundwater use

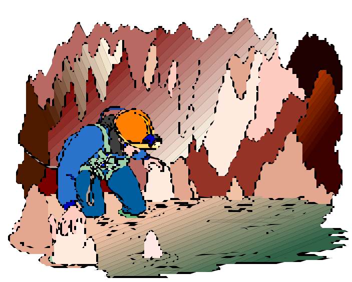
When we talk in terms of the source of the water we use everyday, we consider if the water comes from a surface-water source (river, lake, etc.) or from a ground-water source (from a well or spring). In 1990, about 20 percent of our nation’s water withdrawals were from groundwater sources and about 80 percent were from surface water.

You might think 20 percent is not very much, but ground water is important for many of our uses. For some water-use categories, ground water plays a larger role. For instance, for the 43 million of Americans who supplied their own water at home in 1990, almost 99 percent used ground water.

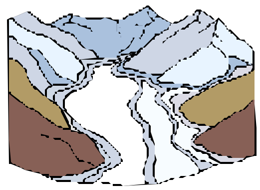
Just because you have a well that yields plenty of water doesn't mean you can go ahead and just take a drink. Because water is such an excellent solvent it can contain lots of dissolved chemicals. And since ground water moves through rocks and subsurface soil, it has a lot of opportunity to dissolve substances as it moves. For that reason, ground water will often have more dissolved substances than surface water will. Even though the ground is an excellent mechanism for filtering out particulate matter, such as leaves, soil, and bugs, dissolved chemicals and gases can still occur in large enough concentrations in ground water to cause problems. Underground water can get contaminated from industrial, domestic, and agricultural chemicals from the surface. This includes chemicals such as pesticides and herbicides that many homeowners apply to their lawns.

Contamination of ground water by road salt is of major concern in some areas of the United States. Salt is spread on roads to melt ice, and, with salt being so soluble in water, excess sodium and chloride is easily transported into the subsurface ground water. The most common water-quality problem in rural water supplies is bacterial contamination from septic tanks, which are often used in rural areas that don't have a sewage-treatment system. Effluent (overflow and leakage) from a septic tank can percolate (seep) down to the water table and maybe into a homeowner's own well. Just as with urban water supplies, treatment may be necessary to kill the dangerous bacteria.

The subject of ground water is not a simple one, and a discussion of it will not fit on these pages! There are people who make their careers studying ground water, trying to model where it exists, how it moves underground, and analyzing how ground water can carry possible contaminants. By the way, it's a myth that all our ground-water supplies are really rivers flowing underground -- except in the case of caves that exist in limestone rock. These caves can have flowing streams in them. Kentucky has many such caves.



Glaciers and icecaps: Storehouses of fresh water



Even though you may never have seen a glacier, they are a big item when we talk about the world's water supply. Almost 10 percent of the world's land mass is currently covered with glaciers, mostly in places like Greenland and Antarctica.

In a way, glaciers are just frozen rivers and they "flow" downhill. Glaciers begin life as snowflakes. When the snowfall in an area far exceeds the melting that occurs during summer, glaciers start to form. The weight of the accumulated snow compresses the fallen snow into ice. These "rivers" of ice are tremendously heavy, and if they are on land that has a downhill slope the whole ice patch starts to slowly grind its way downhill. These glaciers can vary greatly in size, from a football-field sized patch to a river a hundred miles long.

Glaciers have had a profound effect on the topography (lay of the land) in some areas, as in the northern U.S. You can imagine how a billion-ton ice cube can rearrange the landscape as it slowly grinds its way overland. Many lakes, such as the Great Lakes, and valleys have been carved out by ancient glaciers.

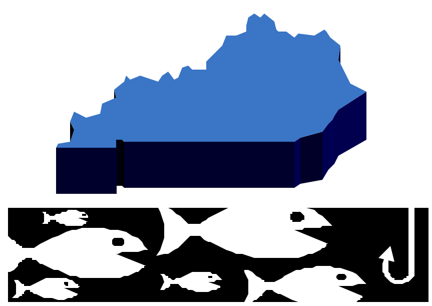
Because the earth is getting warmer, many glaciers and icecaps are melting. Some scientists think the release of this fresh water into the oceans may eventually cause changes in the climate.

Water Quality

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. Although scientific measurements are used to define a water's quality, it's not a simple thing to say that "this water is good," or "this water is bad." After all, water that is perfectly suited to wash a car may not be good enough to serve as drinking water at a dinner party for the President! When the average person asks about water quality, they probably want to know if the water is good enough to use at home, to play in, to serve in a restaurant, etc., or if the quality of our natural waters are suitable for aquatic plants and animals.

More and more nowadays we are hearing about situations where the quality of our water is not good enough for normal uses. Bacteria and microorganisms have gotten into drinking-water supplies, sometimes causing severe illness in a town; chemical pollutants have been detected in streams, endangering plant and animal life; sewage spills have occurred, forcing people to boil their drinking water; pesticides and other chemicals have seeped into the ground and have harmed the water in aquifers; and, runoff containing pollutants from roads and parking lots have affected the water quality of urban streams.

Yes, water quality has become a very big issue today, partly because of the tremendous growth of the Nation's population and urban expansion and development. Rural areas can also contribute to water-quality problems. Inappropriate use or disposal of animal feed, fertilizer, and manure, creates more nitrogen and phosphorus than can be used by crops or animals. These excess nutrients have the potential to degrade water quality if incorporated into runoff from farms into streams and lakes. All this growth puts great stress on the natural water resources, and, if we are not diligent, the quality of our waters will suffer.



Kentucky Water Facts

(From the Kentucky Division of Water)

Average annual rainfall	40-50 inches
Maximum rainfall period	winter and spring
Minimum rainfall period	late summer and fall
Miles of rivers and streams	89,431
Miles of rivers bordering other states	849
Acres of wetlands	637,000
Number of reservoirs over 1000 acres in size	18
Acres of publicly owned lakes and reservoirs	228,385

List of Enviroscape Models Available for Loan in Kentucky

(There may be others – Check with your local Extension Office or Conservation District)

STATEWIDE

Cumberland Valley RC+D
Division of Pesticide Regulation
Division of Water Nonpoint Source Section
East Kentucky Science Center
Eastern Kentucky PRIDE
ENRI Task force-CES-UK
Green River RC+D
Kentucky Ag and Environment in the classroom
Kentucky Heritage RC+D
Kentucky Waterways Alliance
Mammoth Cave National Park
Northern Kentucky University
Pennyrile RC+D
Upper Cumberland River Watershed Watch
WKU Center for Water Resource Studies
WKU Center for Math, Science & Environmental Edu.

County Level

Adair Cooperative Extension Service
Allen County Conservation District
Anderson Conservation District
Bell County Cooperative Extension Service and Conservation District
Boone County

- Cooperative Extension Service
- Conservation District
- Sanitation District #1
- Ockerman Elementary

Bourbon Conservation District
Boyd County Natural Resources Conservation Service
Boyd County Middle School
Boyle County Cooperative Extension Service and Conservation District
Bracken County Cooperative Extension Service and Conservation District
Bullit County – contact Jefferson County
Butler Conservation District
Caldwell Conservation District
Calloway Conservation District
Calloway County: Murray Middle School
Campbell Cooperative Extension Service, Conservation Dist, Sanitation District#1

Carroll Conservation District
Enviroscapes models availabel for schools to borrow (cont.)

Carter Conservation District
Christian Conservation District
Clark Conservation Dist
Clay County High School
Crittenden Conservation District
Cumberland Natural Resources Conservation Service
Daviess County - Utica Elementary School
Elliot County Cooperative Extension Service
Estill County Conservation District
Fayette County

- Bluegrass PRIDE
- Conservation District
- UK Landscape Architecture Department

Fayette County Schools

- Stonewall Elementary
- Winburn Middle School

Fleming County Cooperative Extension Service and Conservation District
Floyd County Extension Service
Franklin County Conservation District
Franklin County KY Div. of Water Management Field Office
Garrard County Conservation District
Graves County Conservation District
Grayson County Extension Service
Greenup County Natural Resources Conservation Service
Hancock County Conservation District
Hardin County Conservation District
Harlan County Conservation Dist
Hopkins County KY Div. Of Water Madison Field Office
Hopkins County Extension Service and Conservation District
Hopkins County Schools

- Jesse Stuart Elementary
- Grapevine Elementary

Jackson County Extension Service
Jefferson County

- Natural Resources Conservation Service
- Hawthorn Elementary
- Seneca High School
- Kennedy Montessori School
- Blackacre State Nature Preserve

Johnson County Extension Service
Kenton County

- Extension Service
- Conservation District

Enviroscape models available for loan to schools (cont.)

Knott County

- Extension Service
- Natural Resources Conservation Service
- Jones Fork Elementary

Knox County Extension Service and Union College Graduate Program
LaRue County Conservation District
Leslie County Extension Service and Conservation District
Letcher County Conservation District
Lewis County Conservation District
Lincoln County Conservation District
Madison County - Berea Community Elementary School
Magoffin County High School
Martin County - Warfield Elementary
Nelson County - Cox's Creek Elementary
Nicholas County - Ryle High School
Oldham County - Buckner Elementary or contact Jefferson County
Pike County - John's Creek Elementary
Pulaski County - Southwestern High School
Rowan County - Tilden Hogg Elementary
Spencer County – contact Jefferson County
Todd County - North Todd Elementary School
Warren County - Lost River Elementary